Hearing loss in motorcyclists: occupational and medicolegal aspects

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Motorcycles have been around as a mode of transport since the latter part of the 19th century, and have long been regarded as irritating and noisy. However, regulations to prevent excess vehicular noise in both urban and sports settings[1,2] seem to be reasonably successful. Kamperman[3] has shown that, in an urban setting, accelerating motorcycles with standard exhausts are no louder than motorcars, and measurements by the Transport Research Laboratory have shown overall motorcycle noise to be within UK legislative limits[4].

One might assume that, as well as sparing the public noise nuisance, these regulations would also protect the rider. However, over the past 10–15 years, as motorcycle development has led to quieter machines with radically improved performance, there has been increasing concern that riders are exposed to excessive noise through turbulent airflow around the helmet—so-called wind-noise[5–12]. The seminal report on this topic (although not the first) was that of Van Moorhem *et al*. in 1981[6]. Apart from the work of our group, there have since been only six published reports on the subject[7–12].

NOISE EXPOSURE

All groups have used essentially similar techniques: a miniature microphone is placed at the rider's ear under the helmet and sound levels are measured in various riding conditions. All these studies show excessive wind noise around the helmet—about 90 dB(A) at 60 km/h and increasing linearly when plotted against the log of speed, to reach 110 dB(A) at 160 km/h. In addition our group has measured the sound attenuation characteristics of various motorcycle helmets—a matter that had previously received only limited attention[9,13]. Modern helmets, we found, offered very poor low-frequency sound attenuation and we also demonstrated a phenomenon of resonance at 250 Hz. The source proved to be a turbulent boundary layer, vibrating against the outside of the helmet shell, with its maximum sound energy focused between 250 and 500 Hz[14,15].

One notable omission before our work was the lack of reliable epidemiological data—in other words, were motorcyclists experiencing hearing loss as a result of their noise exposure? Only two reports had looked at this[11,16] and both concluded that hearing was impaired. One[16], based on non-standard audiometric measurements made in poor acoustical conditions, pointed to a loss of high-frequency hearing. The second looked at Dutch police motorcyclists, pooling the audiometric data for 169 riders (age range 26–49) and comparing them with standard audiometric data for 35-year-olds (source not disclosed). Apart from the effects of age, the investigators therefore neglected other exposures to noise, especially that of firearms (to which they acknowledged ubiquitous exposure).

When we used more suitable controls, we did confirm hearing loss in motorcyclists[17,18]. We also identified a temporary threshold shift after only 1 hour of high-speed riding and a corresponding subjective complaint of tinnitus[19]. After long periods at high speed, riders commonly report other non-specific complaints such as fatigue, headache and even disequilibrium. Similar symptoms have been described in industry and elsewhere[20,21].

PROTECTION

These adverse effects make a strong argument for remedial action, yet little has been done to reduce noise exposure for motorcyclists. The Dutch State Police looked at various helmets and tried handle-bar and fairing modifications to reduce sound levels[22,23]. Success was limited, the best improvement being only 6 dB with a particular handle-bar/fairing combination[22]. American workers made external modifications to standard helmets, with cones to make them more aerodynamic, seals around the visor and seals around the neck; but the best improvement was, again, only about 5 dB. A Swedish group likewise had little success with helmet modifications but did achieve a sound reduction of about 10 dB by incorporating earmuffs under the helmet.

We have investigated two possible solutions—earplugs and pneumatically operated earmuffs. Earplugs proved effective in preventing temporary threshold shift[19], relatively safe in terms of signal detection[25] and beneficial in terms of improved general wellbeing after riding[26]. The earmuffs, fitted inside the helmet shell, are effective in reducing 'at-ear' wind noise and, unlike earplugs, can be

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switched on and off. The importance of auditory cues to motorcyclists has not been proved, but intact hearing is likely to be an advantage in towns (most motorcycle accidents occur in town and at speeds of less than 60 km/h[27]). Although either solution would be effective in reducing the noise exposure of motorcyclists, only the earplug option could be immediately instituted. Unfortunately this option demands the active cooperation of motorcyclists, not all of whom can or will use earplugs. Ultimately, improvements in helmet design seem the best solution.

MEDICOLEGAL ASPECTS

Broadly, there are two types of motorcyclists—amateur and professional. Professional riders can be further subdivided into racers, dispatch riders and police motorcyclists. The amateur rider is unlikely to pursue a claim in court for hearing loss suffered from a leisure activity. For professional riders the situation is different. Racers' risk of injury is generally covered by the terms of their contract, which effectively protects their 'employer' from litigation. Dispatch riders are usually self-employed and subcontract their services to one or more companies; so they too are unlikely to proceed to litigation. Which leaves us with police motorcyclists, who may pursue claims for damage to hearing suffered in the course of their duties. To allow such a claim to proceed, the claimant must fulfil three requirements:

- There has been exposure to excessive noise levels
- There has been a hearing loss as a consequence of that exposure
- There was a foreseeable risk of injury from the exposure and appropriate remedial measures were not instituted (i.e. negligence on the part of the employer).

The first point has already been addressed and the second is usually the reason for starting an action. This leaves us to address the third point, negligence. To fail in his statutory duty to make safe the place of work, an employer must have had reasonable 'knowledge' of the hazard and of appropriate remedial measures. So, what is the 'date of guilty knowledge' for wind noise and hearing loss in motorcyclists? The first available publication was in 1974, and until our work began in 1992 there were only thirteen papers on this subject, of which four were internal reports for the Dutch police and one was in German. Although some concern had been expressed in the motorcycle press in 1989 and 1992, public knowledge of the risk was probably slight. Soon after the start of our project in May 1992, several motorcycle journalists became aware of it and published comments (references available on request). More importantly a letter published in *The Lancet* towards the end of 1992[28] was picked up by much of the national media (see Ref 29). This would set the date of guilty knowledge for risk at the end of 1992 or early in 1993. An alternative point of view, however, puts the date at July 1995 with the publication of our epidemiological article confirming the occurrence of hearing loss in motorcyclists[18].

As regards remedial action there is a question of how quickly it could have been instituted. In 1993, I was asked to suggest and investigate a system for police motorcyclists that would allow them to maintain radio communications[30]. (Incidentally there is no evidence that the radios themselves contribute significantly to the overall noise exposure.) Our feeling was that earplugs were and are still the only realistic option, particularly in the absence of commercially available sound-proof helmets. Apart from the loss of audible signals and consequent increased risk of accidents, the police were worried about the ability to receive radio communications. Further papers have addressed these concerns[25,30]. Knowledge of the efficacy and safety of earplugs as a form of remedial action for motorcyclists did not exist anywhere before 1993; thus appropriate remedial action could not have been instituted safely until at least 1993. It is therefore unlikely (though not impossible) that a hearing loss suffered by a motorcyclist in the course of his employment, before 1992, could be shown to be due to the negligence of his employer. Today, matters are very different.

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